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DIFFERENTIAL ELIMINATION OF MERCURY DURING MATURATION OF LEGUMINOUS SEEDS

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Key Word Index—Leguminosae; fruit; seeds; maturation; loss of mercury; detoxification.

Abstract—The pods of *Acacia koa*, *Canavalia cathartica*, *Leucaena leucocephala*, *Samanea saman* and six other leguminous species lose as much as 75–85% of their tissue water during maturation, but show no loss in tissue mercury content. Unlike fruit, seeds not only lose most of their water content, but also at least 75% of their mercury during the maturation process. It is suggested that selective elimination is more likely to take place by bio-volatilization rather than by translocation, and that the phenomenon allows for detoxification of a cytogenetically hazardous chemical substance.

Seeds and meristems of *Crepis*, *Allium* and *Vicia* exposed to mercury develop cytogenetic abnormalities including C-mitosis, chromosome breakage and possibly gene mutation [1–6]. The threshold concentration for these effects appears to be in the vicinity of 20 ppb in the tissues.

In the many reports concerned with the accumulation of mercury in vascular plant tissues, attention is usually focused on whole shoots, or on specific organs, roots, stems or leaves [7–14]. Analytical data rarely include reproductive organs or structures, although it has been observed that the mercury content of native seeds can be appreciably lower than concentrations found in flowers and fruit [15, 16].

In the course of an extended study of plant–soil mercury relations we had occasion to collect for analysis fruit and seeds of various leguminous species growing in Hawaii. The collection of samples differing in maturity was made simple and convenient by their presence together, often on the same plant. Upon analysis, these samples provided, unexpectedly, evidence for a striking, selective elimination of mercury from seeds during maturation, as we here demonstrate.

Sample collections were made during 1980–1982 on the Island of Oahu in the Manoa Valley (Honolulu), and on the Island of Hawaii in the lower Puna District. Oahu plants were located in old volcanic clay loam soils whereas those on Hawaii grew in ash and cinder-rich media about 20 km southeast of Kilauea volcano.

Following collection, samples were sealed in polyethylene after separation of seeds from fruit tissue (pods), digested within 24 hr and analysed by flameless atomic absorption spectrophotometry [17]. Samples of soils in which plants were growing were also analysed (in triplicate) for mercury content. For every species, triplicate fresh tissue samples, each equivalent to about 5–10 g dry matter, were drawn from pooled collections representing 8–15 plants. These were digested directly. Two additional fresh samples of at least 10 g were withdrawn for determination of dry weight and water content.

Immature fruit was distinguished by its green color, intact structure, and firmly attached green seeds. Mature fruits were brown, the pods split and seeds loose or readily detached, usually brown. Maturation in leguminous fruit is also associated with pronounced water loss, which we also recorded.

During maturation, both pods and seeds lose over half, even as much as 75–85%, of the water in their immature tissues (Table 1). However, although the mercury in pod tissues shows no pattern of consistent change with maturation, the seeds lose at least 75% of their initial metal content in every case investigated here.

Where comparisons are at all possible, e.g. *Cassia*, *Leucaena*, there appears to be a relationship between soil mercury level and tissue mercury content. Overall, however, these differences, while consistent with our earlier findings using vegetative tissue samples [18] may only reflect a weak tendency. The unusual phenomenon of selective mercury elimination seen here in tissues as intimately associated as pod with seed seems quite independent of island site, soil mercury or species.

The well-known mechanism for transport of substances between tissues and organs in vascular plants is translocation, as in the export of photosynthate from leaves. The virtual absence of more than minor variations in pod mercury content is difficult to reconcile with a mechanism for mercury transport from the seed via the vascular system within the fruit. An alternative, elimination by release of elemental mercury as the vapor, has been established for vegetative organs in many vascular plants, including *Leucaena*, but has not been tested with reproductive organs or tissues [19, 20].

Thus no firm distinction can be made at present between these two eliminative processes, but there is no question as to the potential importance of such a detoxification mechanism for propagation, via seeds, of successive generations.

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Table 1. Changes in mercury and water content of leguminous pods and seeds during maturation

		Analysis				
		Pod		Seed		Soil
Species	Fruit status	Water (%)	Mercury (ppb)	Water (%)	Mercury (ppb)	Mercury (ppb)
(a) Oahu						
Acacia koa Gray	Immature	48	67±10	52	57±8	10±2
	Mature	18	71±10	16	15±3	
Cassia glauca Lam.	Immature	56	85±7	50	50±6	16±4
	Mature	14	100±16	12	12±2	
Delonix regia (Bojer)	Immature	55	69±8	52	50±7	14±3
Raf.	Mature	17	61±8	13	10±2	
Leucaena leucocephala (L.)	Immature	57	68±8	59	85±9	20±4
Benth.	Mature	24	79±8	28	14±2	
Samanea saman (Jacq.)	Immature	44	52±7	50	57±7	16±4
Merr.	Mature	18	50±7	11	11±3	
Mezoneuron kauaiense	Immature	59	61±8	55	54±7	21±5
(Mann.) Hbd.	Mature	23	52±7	17	8±1	
(b) Hawaii						
Canavalia cathartica	Immature	49	56±7	49	157±18	48±12
Thou.	Mature	20	66±7	7	21±3	
Cassia bicapsularis L.	Immature	47	178±21	59	101±20	63±16
	Mature	12	150±17	17	21±2	
Crotalaria mucronata	Immature	61	86±11	49	88±10	56±15
Desv.	Mature	24	102±8	14	19±2	
Leucaena leucocephala (L.)	Immature	53	98±10	56	102±13	69±16
Benth.	Mature	20	104±12	21	17±4	
Mucuna gigantea (Willd)	Immature	51	97±12	53	81±12	60±5
DC.	Mature	21	100±14	15	16±3	

Mean plant tissue and soil mercury in parts per billion (dry wt) values are based on triplicate determinations. Average water content is based on duplicate determinations. See text for criteria used in distinguishing mature and immature fruits and seeds.

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